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GB 2292788 A EP 0679618 A EP 0673809 A
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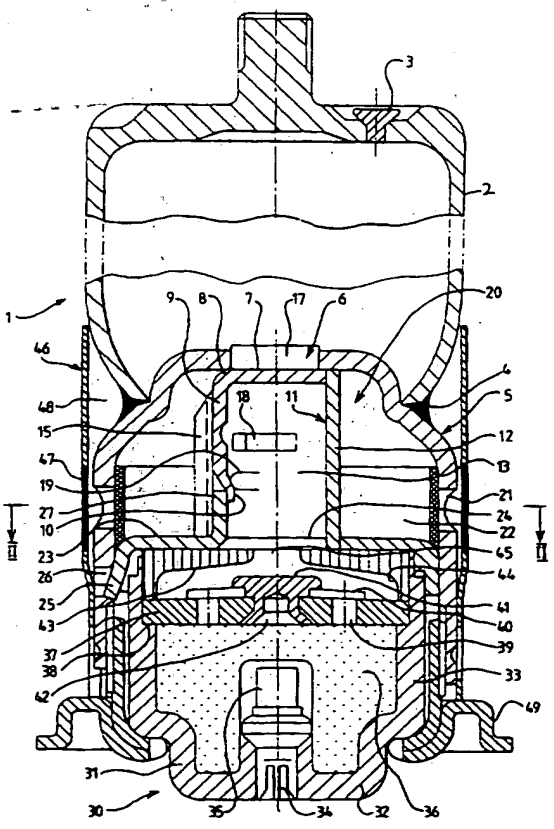
(54) A hybrid gas generator

(57) A hybrid gas generator (1) for a vehicle safety device such as an air-bag comprises a vessel (2) containing a compressed gas. Outside the vessel (2) is a container (30) containing a nitramine based pyrotechnic charge (36). The vessel (2) has an outlet(6) leading to a combustion chamber (20) and the container (30) also has an outlet (45) leading to the combustion chamber (20). The combustion chamber has an outlet (21) which leads to the safety device. The compressed gas within the vessel (2) preferably includes an oxidising gas. The products of ignition of the nitramine charge are thus oxidised by the oxidising gas within the combustion chamber (20).

FIG 1



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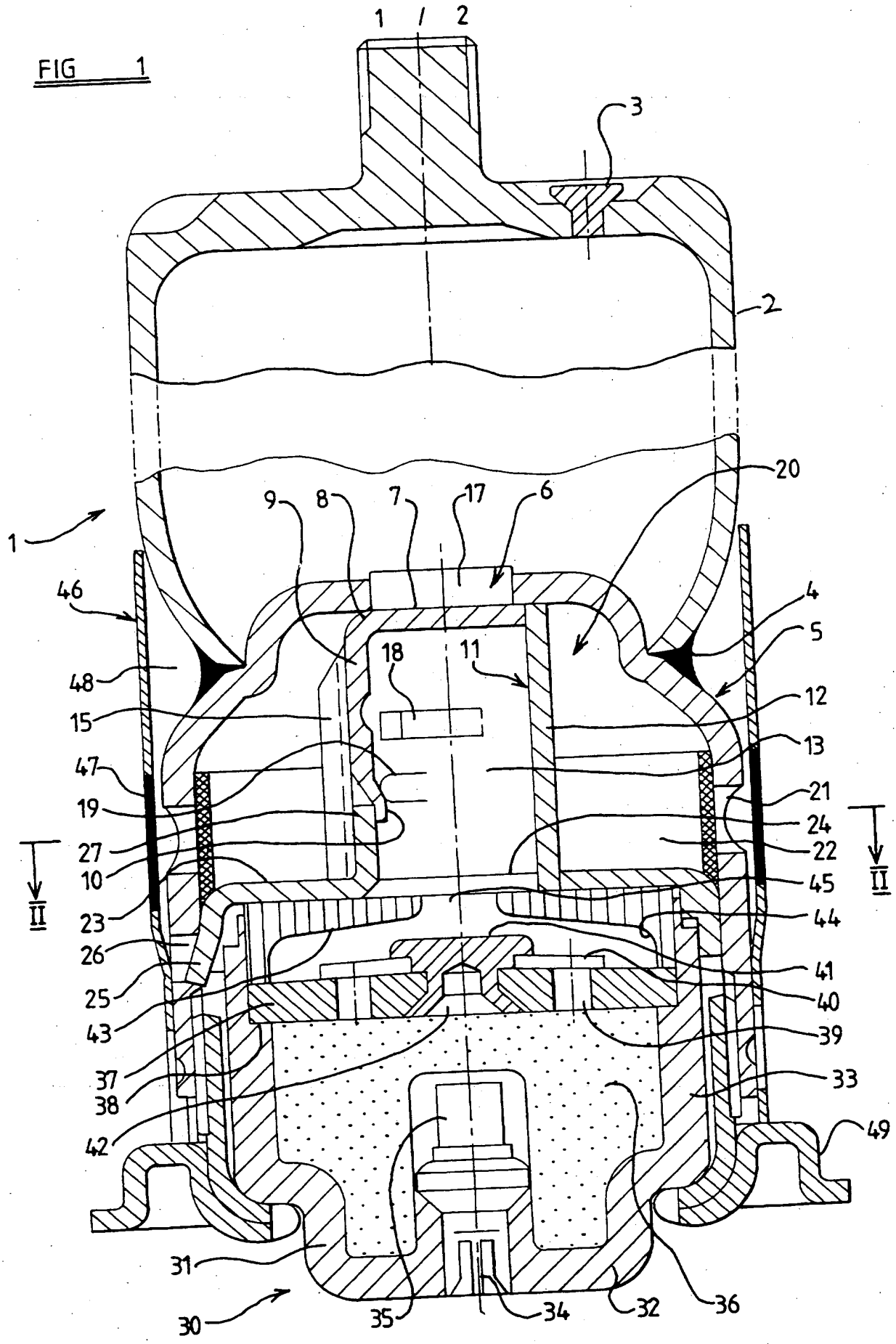
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG 1



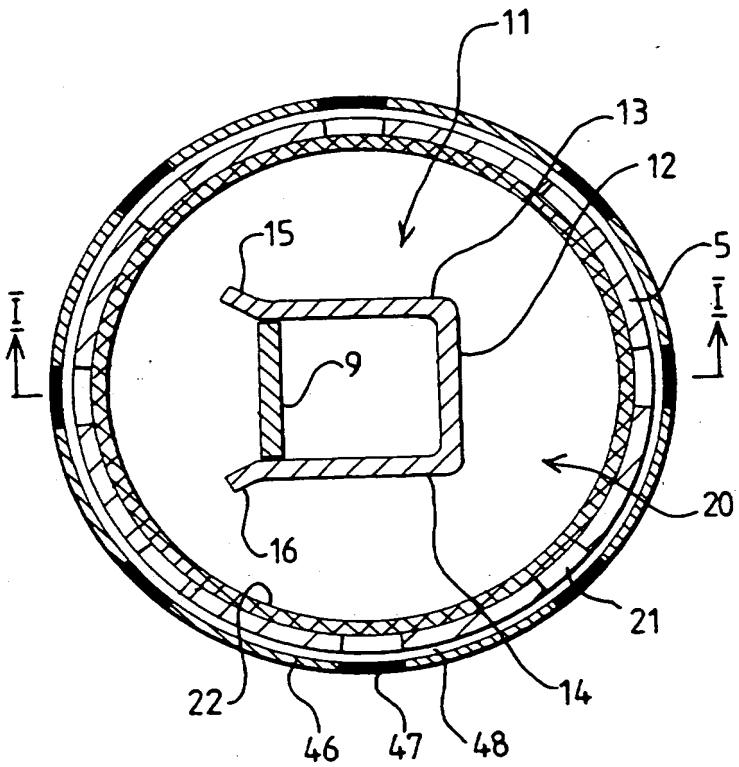


FIG 2

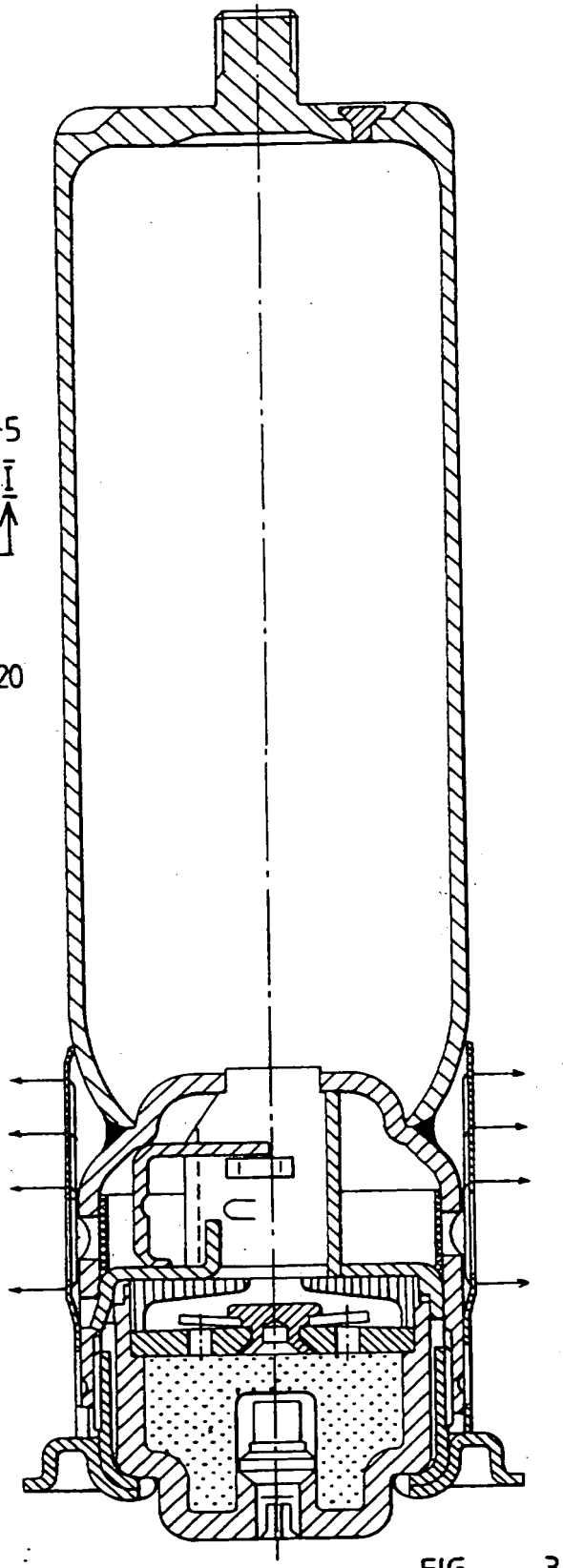


FIG 3

DESCRIPTION OF INVENTION

"IMPROVEMENTS IN OR RELATING TO A GAS GENERATOR"

THE PRESENT INVENTION relates to a gas generator, and more particularly relates to a gas generator intended for use with a safety device in a motor vehicle such as, for example, an air-bag.

It has been proposed previously to provide various types of gas generator for use in connection with safety devices in the motor vehicle. In connection with the inflation of air-bags, however, interest has been shown recently in hybrid gas generators. Such gas generators comprise both a source of compressed gas and a pyrotechnic charge.

One type of hybrid gas generator comprises a sealed vessel containing compressed gas and a pyrotechnic charge, which is most commonly located inside the pressure vessel, consisting principally of sodium azide or nitro cellulose.

Sodium azide is a very toxic material, and consequently difficulties are encountered in manufacturing a hybrid gas generator using this material. When a pyrotechnic charge containing sodium azide is activated, a lot of solid particles are generated, which have to be filtered out of the gas stream before it is fed to an air-bag, and also the gas stream itself is toxic. Sodium azide also deteriorates over a period of time and becomes unstable.

On the other hand, nitro cellulose also becomes unstable after a period of time, and additionally becomes unstable if it is subjected to high temperatures. Nitro cellulose is also sensitive to shock and can thus be ignited in an unintentional manner.

A disadvantage of having the pyrotechnic charge located inside the pressure vessel containing the compressed gas is that the pressure vessel has to be designed to be sufficiently strong to withstand the additional pressure peak that occurs when the pyrotechnic charge is ignited.

It has also been proposed to utilise a pyrotechnic material based on nitramine propellant in a hybrid gas generator. This material is non-toxic and is stable over a long period of time, even if subjected to high temperatures and shocks. The initial ignition of a pyrotechnic charge based on nitramine produces a lot of combustible gases, such as carbon monoxide and hydrogen, which can be burnt or oxidised to generate additional heat. A further advantage of nitramine is that very few solid particles are produced on ignition of a pyrotechnic charge based on this material.

It has been proposed previously, see US-A-5,507,891, to use a nitramine propellant inside a pressure vessel in a hybrid gas generator. This is a suitable environment for nitramine propellant, because the nitramine propellant requires a high counter-pressure to burn in a controlled manner.

The present invention seeks to provide an improved hybrid gas generator.

According to this invention there is provided a hybrid gas generator for a vehicle safety device, comprising a vessel containing compressed gas and, outside said vessel, a container containing a nitramine based pyrotechnic charge, both said vessel and said container having outlets leading to a combustion chamber, the combustion chamber having an outlet which leads to said safety device.

The compressed gas may include an oxidising gas, such as oxygen, nitro-oxide or hydrogen peroxide, the preferred oxidising gas being oxygen.

Advantageously the compressed gas comprises between 10 and 25% and preferably about 19% by volume of oxygen.

Conveniently the compressed gas includes an inert gas, such as argon and/or helium.

Conveniently the compressed gas includes at least 5% helium, and in preferred embodiments at least 70% and up to approximately 76% argon.

Preferably the pressure of the compressed gas is initially in the range of 15-30 MPa, and conveniently approximately 20 MPa.

Advantageously the pyrotechnic charge comprises RDX and/or HMX.

In one embodiment the pyrotechnic charge comprises between 70 and 80% RDX and/or HMX, and also comprises a binder.

Thus the pyrotechnic charge may comprise between 10 and 30% cellulose acetate as said binder, and preferably may comprise 15 to 20% by weight of cellulose acetate as binder.

Alternatively the pyrotechnic charge may comprise between 10 and 20% by weight of polybutadiene as binder.

Conveniently the container for the pyrotechnic charge is associated with a pressure regulator, which may be adapted to maintain a pressure within the container of between 25 and 40 MPa during combustion.

Preferably the pressure regulator comprises a member of resilient material which initially seals one or more apertures leading from the said container.

Advantageously the outlet from the container containing the pyrotechnic charge directs gas generated by combustion of the pyrotechnic charge to move a support plate from an initial position in which the support plate initially supports a foil which seals the said outlet from the vessel containing compressed gas, to cause the seal to rupture.

Preferably the plate supporting the foil is provided with a depending leg, the depending leg terminating with a deformable tab, the tab initially being located between two fixed components, the arrangement being such that on activation of the pyrotechnic charge, gas from the pyrotechnic charge causes the plate and the depending leg to move, deforming the deformable tab.

Conveniently the combustion chamber is of circular form.

Preferably the outlet from the combustion chamber is associated with a net so that gas exiting the combustion chamber flows through the net.

Advantageously the outlet from the combustion chamber leads to an after-burning chamber which is located, in the sense of flow of gas, between the combustion chamber and the safety device to be supplied with gas.

Preferably the after-burning chamber is of annular form and surrounds the combustion chamber.

Conveniently the after-burning chamber has a volume of about 20% of the volume of the combustion chamber.

In one embodiment the after-burning chamber is defined by a cylindrical sleeve located around the exterior of the combustion chamber.

Preferably the outer wall of the sleeve has an area which is perforated, the total area of the openings of the perforations being 15-30% of the wall area.

Conveniently the area of the sleeve immediately adjacent the or each outlet from the combustion chamber is imperforate.

The gas generator may be adapted so that, on operation, the pressure within the combustion chamber is 1-15 MPa.

The gas generator may also be adapted so that on operation, the pressure within the after-burning chamber is 2-10 MPa.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a vertical sectional view of a hybrid gas generator intended for use with an air-bag in a motor vehicle taken on line I-I of Figure 2,

FIGURE 2 is a sectional view of the arrangement of Figure 1 taken on the line II-II, and

FIGURE 3 is a view corresponding to Figure 1 illustrating the gas generator during operation.

Referring initially to Figure 1, a gas generator 1 in accordance with the invention comprises a cylindrical pressure vessel 2, being provided, at one end, with a filling plug 3 which is inserted in position after the pressure vessel has been filled. The pressure vessel is filled with a compressed gas which includes an oxidising gas. The oxidising gas may be oxygen, nitro-oxide (N_2O) or hydrogen peroxide (H_2O_2), the preferred oxidising gas being oxygen. The compressed gas thus preferably comprises between 10 and 25% by oxygen, the preferred proportion of oxygen being about 19%. The compressed gas preferably also contains an inert gas or a mixture of inert gases such as, for example, argon and/or helium. The preferred compressed gas comprises 5% helium, with the remaining portion of the gas comprising argon. Thus the gas may comprise at least 70% (or more) argon.

The initial pressure of gas within the pressure vessel 2 is preferably in the range of 15-30 MPa, the

preferred pressure being 20 MPa, the pressure being taken at 25^{0}C.

The end of the pressure vessel 2, which is remote from the filling plug 3, is secured, by means of a welding fillet 4 to the exterior of a generally cylindrical housing 5 which, as will be described hereinafter, contains a pyrotechnic charge. A part of the housing 5 defining a substantially closed end of the housing 5 extends into the pressure vessel 2 and defines an opening 6 which communicates with the interior of the pressure vessel 2. The opening 6 is initially sealed by means of a foil 7 which is welded or otherwise secured in position, the foil initially being supported by a plate 8 which is located in position on the side of the aperture 6 remote from the interior of the pressure vessel 2. The plate 8 is provided, at one side, with a depending leg 9, the depending leg 9 terminating with a relatively weak deformable tab 10.

The plate 8 and depending leg 9 are contained within an upstanding guide 11 which, when viewed from above, is of substantially "U" shape. Thus, as can be seen most clearly in Figure 2, the guide 11 comprises a rear wall 12, and two spaced apart side walls 13,14. The side walls terminating with slightly divergent lips 15,16. As can be seen in Figure 1, the side wall 13 has, at its upper edge, a portion 17 which passes through the aperture 6, to secure the guide 11 in position, the wall 14 being of a similar configuration. The side wall 13 carries, substantially centrally, an inwardly directed protrusion 18 and, adjacent the deformable tab 10, a further protrusion 19.

The interior of the housing 5 defines a chamber 20 which surrounds the combination of the guide 11 and the plate 8 with its depending leg 9. The part of the housing 5 that surrounds the annular region 20 is a cylindrical wall provided with a plurality of evenly spaced radially outwardly opening apertures 21. Extending around the interior of the cylindrical wall of the housing, adjacent the apertures 21, is a net 22 which may be formed of a metal mesh or the like.

An annular retaining ring 23 which retains the guide 11 and the associated plate in position defines a central aperture 24 and, atone side, a tab 25 which is snap-fitted into an aperture 26 formed in the cylindrical wall of the housing 5 to secure the retaining ring 23 in position. The retaining ring 23 has an upstanding leg 27.

The lower part of the housing 5 is an open end of the housing which receives a cartridge 30 containing a pyrotechnic charge. The cartridge comprises a container 31 having a base 33 and an annular upstanding side wall 33. Formed in the base 32 is a connector 34 leading to an ignition squib 35 located on the interior of the container. The ignition squib 35 is surrounded by a pyrotechnic charge 36.

The pyrotechnic charge is based on a nitramine propellant and comprises RDX and/or HMX. The pyrotechnic charge preferably also comprises a binder. The preparation of RDX and/or HMX may be between 70 and 80% The binder may be cellulose acetate (CA) in which case the binder is present in the range of 10-30% by weight, preferably 15-20%. Alternatively, the binder may be polybutadiene (PB) in which case it is preferred that the binder comprises 10-20% by weight of the pyrotechnic charge.

The upper open end of the container 31 is closed by a disc 37 which is received on a shoulder 38 formed on the side wall 33 of the container 31. The disc 37 defines a plurality of axially extending apertures 39. In an alternative embodiment only one aperture 39 need be provided. The apertures 39 are initially sealed by means of a resilient annular sealing ring 40 which is held in position by means of a stud 41 which is received in a centrally located aperture 42 formed in the disc 37. An annular insert 43 is provided with a depending peripheral skirt 44 which abuts the inner surface of the upper part of the side wall 33. The upper part of the insert 43 defines a central aperture 45 which is aligned with an aperture 24 formed in the retaining ring 23.

An annular sleeve 46 is provided located on the exterior of the housing 5, again formed of a substantially net-like material, the annular sleeve 46 having impervious areas 47 located adjacent the radially outwardly directed apertures 21.

The net forming the annular sleeve 46 is such that the total area of the openings or perforations forming 15 to 30% of the surface area of the sleeve.

A chamber 48 is defined between the sleeve 46 and the exterior of the housing 5. The volume of the chamber 48 is approximately 20% of the volume of the chamber 20 defined within the housing 5.

An annular clip 49 engages thee inner part of the side wall of the housing 5 and also engages the container 31 and the sleeve 46 to retain the container and the sleeve in position.

On actuation of the igniting squib 35, the pyrotechnic charge 36 is ignited. Gas under pressure is created, that gas flowing through the apertures 39, causing the resilient annular sealing ring 40 to yield to permit the gas to escape. The annular sealing ring 40 thus acts as a spring-biassed valve performing the function of a pressure regulator to maintain a pressure within the container 31, during combustion of the pyrotechnic material, of between 25 and 40 MPa. Temperatures of between 2,500 and 3,000^{0}C may be achieved during this combustion. The gas, having passed the annular spring 40 is guided by the insert 43 to flow through the co-aligned apertures 45 and 24, the gas thus being introduced to the space between the guide 11 and the combination of the plate 8 and the depending leg 9.

When subjected to high pressure, the combination of the plate 8 and the depending leg 9 move towards the left, as shown in Figure 1, with the deformable tab 10 being deformed. The plate and leg thus move to the position illustrated in Figure 3. The sealing foil 7 is no longer supported by the plate 8 and, as a consequence of the high pressure present within the pressure vessel 2, the foil bursts. Alternatively the foil may tear as the plate 8 moves relative to the foil 7. Gas from the pressure vessel thus flows downwardly through the aperture 6.

The gas from the pressure vessel and the gas from the ignition of the pyrotechnic charge thus meet within the chamber 20 defined within the housing 5, which acts as a combustion chamber. The combustion chamber is of circular form and within this chamber, the oxidising gas from the pressure vessel begins to oxidise any oxidisable gases generated by the combustion of the pyrotechnic charge. These gases will comprise carbon monoxide and hydrogen.

Within the combustion chamber the pressure may be between 5 and 15 MPa, and the temperature may be up to 1,500^{0}C.

Gas from the combustion chamber flows through the net 22 towards the apertures 21. On flowing through the net 22 small areas of turbulence are generated which thoroughly mix the gases forming the gas flow. The mixed gases pass through the apertures 21 into the chamber defined between the exterior of the housing 5 and the annular sleeve 46.

Because the areas 47 immediately adjacent the apertures 21 are not perforated, the gas leaving the apertures 21 cannot flow immediately through those areas of the annular sleeve 46, but must first flow axially within the annular chamber 48 which comprises an after-burning chamber. This after-burning chamber has a volume of about 20% of the volume of the combustion chamber 20.

Further combustion occurs with the after-burning chamber 48, and typically the pressure within the after-burning chamber is between 2 and 10 MPa and the temperature is of the order of 1,000^{0}C. When the combustion is complete, the resultant gas flows outwardly through the net portions of the annular sleeve 46 and may thus inflate an air-bag which initially surrounds the gas generator.

Whilst the invention has been described with reference to an embodiment specifically adapted to inflate an air-bag, it is to be appreciated that gas generators in accordance with the invention may be utilised in connection with other safety devices in a motor vehicle.

CLAIMS:

1. A hybrid gas generator for a vehicle safety device, comprising a vessel containing compressed gas and, outside said vessel, a container containing a nitramine based pyrotechnic charge, both said vessel and said container having outlets leading to a combustion chamber, the combustion chamber having an outlet which leads to said safety device.

2. A gas generator according to Claim 1 wherein the compressed gas includes an oxidising gas.

3. A gas generator according to Claim 2 wherein the oxidising gas comprises oxygen, nitro-oxide or hydrogen peroxide.

4. A gas generator according to Claim 3 wherein the oxidising gas is oxygen.

5. A gas generator according to Claim 3 wherein the compressed gas comprises between 10 and 25% by volume of oxygen.

6. A gas generator according to Claim 5 wherein the compressed gas comprise about 19% by oxygen.

7. A gas generator according to any one of the preceding Claims wherein the compressed gas includes an inert gas.

8. A gas generator according to Claim 7 wherein the inert gas comprises argon and/or helium.

9. A gas generator according to Claim 8 wherein the compressed gas includes at least 5% helium.

10. A gas generator according to any one of Claims 7 or 8 wherein the compressed gas contains at least 70% argon.

11. A gas generator according to Claim 10 wherein the compressed gas comprises approximately 76% argon.

12. A gas generator according to any one of the preceding Claims wherein the pressure of the compressed gas is initially in the range of 15-30 MPa.

13. A gas generator according to Claim 12 wherein the pressure of the compressed gas is initially approximately 20 MPa.

14. A gas generator according to any one of the preceding Claims wherein the pyrotechnic charge comprises RDX and/or HMX.

15. A gas generator according to Claim 14 wherein the pyrotechnic charge comprises between 70 and 80% RDX and/or HMX, and also comprises a binder.

16. A gas generator according to Claim 15 wherein the pyrotechnic charge comprise between 10 and 30% cellulose acetate as said binder.

17. A gas generator according to Claim 16 wherein the pyrotechnic charge comprises 15 to 20% by weight of cellulose acetate as binder.

18. A gas generator according to Claim 15 wherein the pyrotechnic charge comprises between 10 and 20% by weight of polybutadiene as binder.

19. A gas generator according to any one of the preceding Claims wherein the container for the pyrotechnic charge is associated with a pressure regulator.

20. A gas generator according to Claim 19 wherein the pressure regulator is adapted to maintain a pressure within the container of between 25 and 40 MPa during combustion.

21. A gas generator according to Claim 20 wherein the pressure regulator comprises a member of resilient material which initially seals one or more apertures leading from the said container.

22. A gas generator according to any one of the preceding Claims wherein the outlet from the container containing the pyrotechnic charge directs gas generated by combustion of the pyrotechnic charge to move a support plate from an initial position in which the support plate initially supports a foil which seals the said outlet from the vessel containing compressed gas, to cause the seal to rupture.

23. A gas generator according to Claim 22 wherein the plate supporting the foil is provided with a depending leg, the depending leg terminating with a deformable tab, the tab initially being located between two fixed components, the arrangement being such that on activation of the pyrotechnic charge, gas from the pyrotechnic charge causes the plate and the depending leg to move, deforming the deformable tab.

24. A gas generator according to any one of the preceding Claims wherein the combustion chamber is of circular form.

25. A gas generator according to any one of the preceding Claims wherein the outlet from the combustion chamber is associated with a net so that gas exiting the combustion chamber flows through the net.

26. A gas generator according to any one of the preceding Claims wherein the outlet from the combustion chamber leads to an after-burning chamber which is located, in the sense of flow of gas, between the combustion chamber and the safety device to be supplied with gas.

27. A gas generator according to Claim 26 wherein the after-burning chamber is of annular form and surrounds the combustion chamber.

28. A gas generator according to Claim 26 or 27 wherein the after-burning chamber has a volume of about 20% of the volume of the combustion chamber.

29. A gas generator according to any one of Claims 26 to 28 wherein the after-burning chamber is defined by a cylindrical sleeve located around the exterior of the combustion chamber.

30. A gas generator according to Claim 29 wherein the outer wall of the sleeve has an area which is perforated, the total area of the openings of the perforations being 15-30% of the wall area.

31. A gas generator according to Claim 30 wherein the area of the sleeve immediately adjacent the or each outlet from the combustion chamber is imperforate.

32. A gas generator according to any one of the preceding Claims adapted so that, on operation, the pressure within the combustion chamber is 5-15 MPa.

33. A gas generator according to Claim 26 or any Claim dependent thereon adapted so that on operation, the pressure within the after-burning chamber is 2-10 MPa.

34. A gas generator substantially as herein described with reference to and as shown in the accompanying drawings.

35. Any novel feature or combination of features disclosed herein.

The Patent Office

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Application No: GB 9626503.8 **Examiner:** R C Squire
Claims searched: 1 to 34 **Date of search:** 13 March 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F3A

Int Cl (Ed.6): B60R; C06D; F42B

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2292788A	AUTOLIV	1-5 at least
Y	WO 94/26563A	AUTOLIV (see particularly figs. 4 to 7)	1-5 at least
Y	EP 0679618A	FRAUNHOFER	1 at least
Y	EP 0673809A	QEA (see particularly claims 1-4)	1-5 at least
Y	US 5507891	ZEIGLER	1-5 at least
X	US 5125684	CARTWRIGHT (see particularly claims 1 and 19)	1-5 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.